Junior doctors' urine output on an intensive care unit: case-control study

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EDITORIAL by Annas

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OBJECTIVE To compare urine output between junior doctors in an intensive care unit and the patients for whom they are responsible.

DESIGN Case-control study.

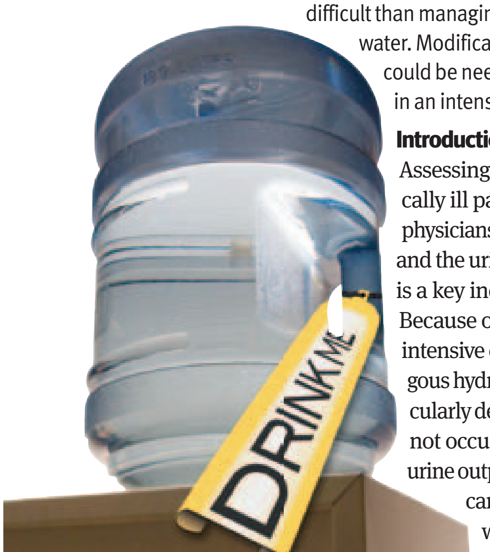
SETTING General intensive care unit in a tertiary referral hospital.

PARTICIPANTS 18 junior doctors responsible for clerking patients on weekday day shifts in the unit from 23 March to 23 April 2009 volunteered as "cases." Controls were the patients in the unit clerked by those doctors. Exclusion criteria (for both groups) were pregnancy, baseline estimated glomerular filtration rate <15 ml/min/1.73 m^2, and renal replacement therapy.

MAIN OUTCOME MEASURES Oliguria (defined as mean urine output <0.5 ml/kg/hour over six or more hours of measurement) and urine output (in ml/kg/hour) as a continuous variable.

RESULTS Doctors were classed as oliguric and "at risk" of acute kidney injury on 19 (22%) of 87 shifts in which urine output was measured, and oliguric to the point of being "in injury" on one (1%) further shift. Data were available for 208 of 209 controls matched to cases in the data collection period; 13 of these were excluded because the control was receiving renal replacement therapy. Doctors were more likely to be oliguric than their patients (odds ratio 1.99, 95% confidence interval 1.08 to 3.68, P=0.03). For each additional 1 ml/kg/hour mean urine output, the odds ratio for being a case rather than a control was 0.27 (0.12 to 0.58, P=0.001). Mortality among doctors was astonishingly low, at 0% (0% to 17.6%).

CONCLUSIONS Managing our own fluid balance is more difficult than managing it in our patients. We should drink more water. Modifications to the criteria for acute kidney injury could be needed for the assessment of junior doctors in an intensive care unit.



Introduction

Assessing the intravascular fluid balance in critically ill patients is a crucial role of intensive care physicians. When intrinsic renal function is normal and the urinary tract is unobstructed, urine output is a key indicator of intravascular volume status. Because of pressure of work, doctors working in intensive care sometimes delay their own autologous hydration and might become "dry" (intravascularly deplete). We hypothesised that this should not occur to such an extent as to lower doctors' urine output below that of the patients in intensive care. In this prospective case-control study we compared the urine output of intensive care doctors and their patients.

Methods

The study was performed in a 17 bed general intensive care unit in a tertiary referral hospital in London over 22 consecutive weekdays (23 March to 23 April 2009). All junior doctors working on the unit who took responsibility for the daily clerking of one or more patients on day shifts during the study were fully informed of the objectives and were eligible to volunteer as cases. The weight of each doctor was determined (wearing scrubs but no footwear, seated and still, having divested themselves of stethoscope, pager, and pocket contents).

For each case, controls comprised the patients on the unit clerked by the case that day. On any day, a case can have been matched with more than one control. During data collection, patients (controls) were allocated to doctors (cases) by the specialist registrar in charge of the unit (based on multiple factors, including patients' diagnoses and overall complexity and the interests and experience of the available doctors), as normal. We determined the patients' weights either by self report, from relatives, from the most recent weight documented in the medical notes or by estimating their weight.

Pregnancy, estimated glomerular filtration rate <15 ml/min/1.73 m^2 (chronic kidney disease stage 5), and renal replacement therapy (including renal transplantation) were exclusion criteria for both cases and controls.

On each data collection day, participating doctors emptied their bladders on arrival at work, noting the time at which they did so on anonymised charts fixed to the inside of the male and female staff changing rooms. On each subsequent occasion during the course of their working day, they measured the volume of urine voided using a wide mouthed 1 l plastic measuring jug and recorded the amount on the appropriate chart. Regardless of whether or not they had the urge to do so, they voided once more at the conclusion of their shift, noting the volume of urine and the time at which it was passed.

Hourly urine volume passed by controls was recorded on flow charts, as normal. As day shifts for doctors start at 8 am and are scheduled to finish between noon and 6 pm but occasionally overrun, we included control data for the period 8 am to 8 pm. We included data only for the period in which patients were admitted to the unit.

We placed no restrictions on the use by either doctors or controls of fluids (whether oral or intravenous) or diuretics (including loop diuretics, thiazides, and foods and drinks containing caffeine) with the exception of alcohol, which was not used by either group. Each participating doctor was offered a single 300 ml cup of caffeinated coffee at the multidisciplinary team ward round each morning, but he or she was not obliged to drink it: its consumption and any subsequent fluid intake was at the discretion of the individual and not recorded.

Statistical analyses

The exposure of main interest was oliguria as a binary variable. A commonly accepted definition of oliguria is a urine output <0.5 ml/kg for each of six or more consecutive hours, which is thought to confer "risk" of renal injury; when urine output <0.5 ml/kg persists for 12 or more consecutive hours, the kidneys are designated to be "in injury."[1] Use of this definition of oliguria was only possible for controls not cases (because of lack of routine catheterisation of doctors on shift). We therefore defined oliguria for both cases and controls as a mean urine output <0.5 ml/kg/hour over a period of six or more hours of measurement. (For full details of statistics see bmj.com.)

Results

Eighteen doctors (12 men, six women) volunteered for the study, contributing a total of 87 case days (range per case 1-13 days, median 5, 74% of eligible case days). Non-participation on any day was invariably attributed to forgetfulness.

For case days, mean and median urine outputs were 0.77 ml/kg/hour and 0.68 ml/kg/hour respectively. In 22 (25%) of 87 case days, the mean shift long urine output was <0.5 ml/kg/hour. Twenty of these shifts lasted more than six hours, including one that lasted for more than 12 hours (mean shift length 9.2 (SD 1.9) hours, range 4.5-12.3 hours). Assuming doctors' urine output was relatively constant throughout each shift, doctors were "at risk" of acute kidney injury (based on urine output criteria[1]) on 19 shifts (22%) and "in injury" on one further shift (1%). Ten (six men, four women; 55%) of 18 cases had at least one day (range 1-3 days) "at risk" of renal injury or worse over the course of the study.

We analysed data for 195 control days paired to case days in 87 strata; each stratum therefore had an average of 2.2 control days. Controls had mean urine output <0.5 ml/kg/hour on 29 (15%) of these 195 control days.

Pooling 20 oliguric case days together with 29 oliguric control days and considering oliguria as a risk factor, the odds ratio for being a case rather than a control (given the presence of oliguria) was 1.99 (95% confidence interval 1.08 to 3.68, P=0.03). With output assessed as a continuous variable, for each additional 1 ml/kg/hour mean urine output, the odds ratio for being a case rather than a control was about one quarter (0.27, 0.12 to 0.58, P=0.001). For both primary and secondary analyses, being a doctor was associated with lower urine output; our data monitoring committee therefore stopped the study early on safety grounds. (Several of us also reached the end of our intensive care unit attachment.)

Discussion

Doctors were twice as likely as their patients to be oliguric. We hope (and expect, given that most do not work as hard as us) that these results are not generalisable to the whole UK medical workforce.

A surprising lack of mortality

A previous study of 41 972 admissions to 22 intensive care units determined that 17% of patients were "at risk" of acute kidney injury at some time during their stay in intensive care and 11% had "injury."[2] In that series, patients without acute kidney injury had mortality rates in hospital of 8%, while those with risk of injury had mortalities of 21% and 46%, respectively.[2] The cumulative 0% (95% confidence interval 0% to 17.6%) mortality in our (frequently oliguric) cases seems nothing short of miraculous in comparison and is presumably attributable to the robust constitutions of doctors on our unit. We did not collect mortality data on controls.

Urine output might be a "softer" marker of acute kidney injury than changes in serum biochemistry. This could explain why mortality was higher for each stratum of acute kidney injury in the series of intensive care patients outlined above.[2] An alternative explanation could be the need for separate acute kidney injury criteria in patients in intensive care units and their doctors.

All our controls had urine output monitored on an hourly basis by experienced intensive care nurses, 24 hours a day; such data are not merely recorded but acted on. Similar close monitoring of urine output with consequent appropriate intervention for doctors has been declined by our nursing staff, even after presentation of these results, and despite advice from the Royal College of Nursing that "looking after colleagues . . . helps to build trust and increase feelings of security" in the workplace.[3] This might be an important issue to address as our data suggest that auto-fluid balance management is more difficult than auto-appendicectomy, which has been successful in 100% of published attempts in the past five decades.[4] An obvious parallel conclusion to be drawn here is that medicine is far more complex than surgery.

Accuracy of methods

The common belief that timed urine self collections are inherently inaccurate is, in fact, a misconception: in a recent UK study of dietary sodium intake, of 751 24 hour urine collections by members of the public, 692 (92%) were objectively assessed as complete or near-complete.[5] Our urine was self collected by medically trained individuals in a single location to which participants were essentially confined for the duration of their shift; the unit had one male and one female washroom, and notices concerning the study were prominently displayed in both. Reminders of the importance of accurate collection were also given to each participating doctor on a daily basis.

Study weaknesses

We did not prescribe or record the intake of fluids in cases. We were unable to record an objective measure of each doctor's stress each day and can therefore not exclude an antidiuretic effect of stress induced vasopressin release. We also cannot rule out a Hawthorne effect. Finally, we did not attempt to ultrasonographically exclude postmicturition urinary retention in our cases at the end of each shift.

Implications

Oligoanuria is usually acute renal success rather than failure, being a sophisticated response to tubular damage caused by renal hypoperfusion or nephrotoxins, preventing life threatening polyuria when reabsorption of glomerular filtrate is impaired.[6] The frequency with which this response was manifest in our doctors could (as suggested by our renal and intensive care physician) be interpreted as a demonstration of the physiological superiority of doctors in intensive care units or merely show (as suggested by the rest of us) that we should try to drink more water while on shift. We need a functioning water fountain in the staff room and the sense to go and drink from it.

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Ethical approval: The study protocol was reviewed by the Wandsworth Research Ethics Committee, who ruled that the study was a survey and that therefore, under NHS research governance arrangements, did not require formal ethical approval (00105.09).

Phantom vibration syndrome among medical staff

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OBJECTIVE To describe the prevalence of and risk factors for experiencing "phantom vibrations," the sensory hallucination sometimes experienced by people carrying pagers or cell phones when the device is not vibrating.

DESIGN Cross sectional survey.

SETTING Academic medical centre.

PARTICIPANTS 176 medical staff who responded to questionnaire (76% of the 232 people invited).

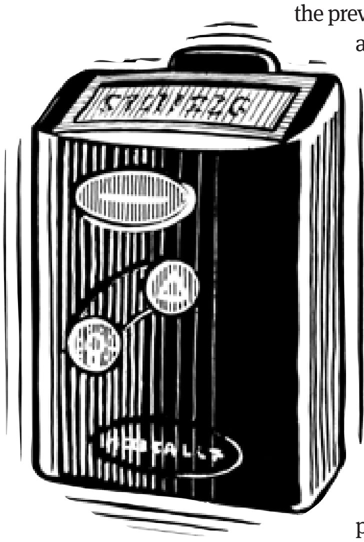
MEASUREMENTS Electronic survey consisting of 17 questions about demographics, device use, phantom vibrations experienced, and attempts to stop them.

RESULTS Of the 169 participants who answered the question, 115 (68%, 95% confidence interval 61% to 75%) reported having experienced phantom vibrations. Most (68/112) who experienced phantom vibrations did so after carrying the device for between 1 month and 1 year, and 13% experienced them daily. Four factors were independently associated with phantom vibrations: occupation (resident *v* attending physician), device location (breast pocket *v* belt), hours carried, and more frequent use in vibrate mode. Strategies for stopping phantom vibrations included taking the device off vibrate mode, changing the location of the device, and using a different device.

CONCLUSIONS Phantom vibration syndrome is common among those who use electronic devices.

Introduction

Electronic devices, such as pagers and cell phones, have become ubiquitous in the information age. In order to maintain electronic access in quiet areas, users often place such devices on "vibrate" mode. Repeated use of the vibration mode may result in intermittent perception that the device is vibrating when, in fact, it is not. This sensation, sometimes referred to as phantom vibration syndrome, has been described in the lay press,[1] but its prevalence has not been established. We conducted a survey of medical professionals who are expected to carry an electronic communication device in order to assess the prevalence of this phenomenon and other factors associated with it.



THOM FERRIER

Methods

In May 2010 we conducted a cross sectional survey of medical staff at Baystate Medical Center, western Massachusetts, and at an affiliated health centre. Because this was a hypothesis generating study, we did not perform a sample size calculation. Instead, all internal medicine staff and students who were on the hospital paging system received an email invitation to participate in an online survey about electronic devices such as pagers and cell phones. Members of the mailing list also received two follow-up reminders at roughly one week intervals.

The survey contained 17 questions, including potential factors associated with phantom vibrations—age (in 10 year increments), sex, occupation, the type of device used, whether the device was used in vibration mode, where it was worn, and how frequently it rang—and whether the respondent has experienced phantom vibrations (survey available on request). For those who reported phantom vibrations, we also asked how often they occurred, how bothersome they were, what methods users employed to stop the vibrations, and whether any of these were successful. The survey was pilot tested to assure clarity and coherence and was approved by the institutional review board of Baystate Medical Center.

Statistical analysis

We conducted comparisons between the primary outcome (presence or absence of phantom vibrations) and categorical variables using Fisher's exact test and Cuzick's non-parametric test for trends.[2] Our multivariable analyses used Poisson regression with robust standard errors in order to facilitate interpretation of the prevalence ratios and to produce valid estimates of the confidence intervals for prevalence ratios.[3]

For univariable analyses, observations with missing data for specific variables were excluded from analyses using those variables (that is, casewise deletion). Multivariable models were based on observations with valid values for all variables included in the final model (that is, listwise deletion) Associations from univariable and multivariable analyses were considered significant at a critical test level of 5%.

Results

Of the 232 people who received the email invitations, 176 (76%) responded (see bmj.com for details of their characteristics). In all, 115/169 (68%, 95% confidence interval 61% to 75%) reported having experienced phantom vibrations. Phantom vibrations were equally common with pagers and cell phones (99/145 (68%) *v* 96/139 (69%), P=0.80). Most respondents began experiencing phantom vibrations after carrying the device for between one month and one year (68/112 (61%, 51% to 70%)), but 18 (16%) experienced them after less than a month, and 26 (23%) did not experience them until they had used the device for a year or more (table 1). Most respondents experienced the phantom vibrations either weekly or monthly (97/111 (87%, 80% to 93%)), but 14 (13%, 7% to 20%) experienced them on a daily basis.

Secondary analyses

In univariate analysis, five factors were associated (defined as P<0.05) with experiencing phantom vibrations: age, occupation, device location, hours worn per day, and how often the device was used in vibrate mode. In multivariable analysis, only occupation (or age), device location, and how often the device was in vibrate mode remained significantly associated with phantom vibrations (table 2 on bmj.com). Because age and occupation were highly co-linear in this sample, it was impossible to estimate their effects on phantom vibrations simultaneously. Both variables had a similar influence on the other variables when modelled separately.

TABLE 1 | CHARACTERISTICS OF PHANTOM VIBRATIONS EXPERIENCED BY 115 RESPONDENTS TO SURVEY OF PHANTOM VIBRATION SYNDROME

Characteristic	No (%) of respondents*
Ever experienced phantom vibrations	115
Bothersomeness:	
Not at all	37/114 (32)
A little	69/114 (61)
Bothersome	6/114 (5)
Very bothersome	2/114 (2)
Duration of use of device before phantom vibrations began:	
<1 month	18/112 (16)
1–5 months	46/112 (41)
6–12 months	22/112 (20)
>12 months	26/112 (23)
Frequency of phantom vibrations:	
Daily	14/111 (13)
Weekly	43/111 (39)
Monthly	54/111 (49)
Succeeded in stopping the phantom vibrations	43/111 (39)
Moving the device	
Helpful	29/105 (28)
Not helpful	17/105 (16)
Not attempted	59/105 (56)
Stop using in vibrate mode	
Helpful	27/103 (26)
Not helpful	9/103 (9)
Not attempted	67/103 (65)
Change device	
Helpful	7/99 (7)
Not helpful	7/99 (7)
Not attempted	85/99 (86)

*Numbers adjusted for those who did not answer the particular question.

Most respondents who experienced phantom vibrations found the sensation to be not at all or only a little bothersome (106/114 (93%, 87% to 97%)). However, 8/114 respondents (7%, 2% to 12%) found the sensation to be bothersome or very bothersome. Finally, of those who experienced phantom vibrations, 43/110 (39%, 30% to 48%) were able to stop them. Strategies for stopping them included taking the device off vibrate mode, changing the location of the device, and using a different device (success rates of 27/36 (75%) *v* 29/46 (63%) *v* 7/14 (50%) respectively, P=0.217). Interestingly, 42/108 (39%, 30% to 49%) respondents did not attempt any strategies to stop the phantom vibrations.

Discussion

In this cross sectional survey of medical staff, we found that almost 70% had experienced phantom vibrations from an electronic device. The perceptions were most common among students and house staff and were associated with frequency of use. Most respondents found the sensations to be only mildly annoying, but 2% found them very bothersome. As a result, only 61% had tried to stop them, and most of those who tried succeeded in extinguishing the sensation—either by moving the device or refraining from using it in vibrate mode.

The cause of phantom vibration syndrome has not been explored, but the extremely high prevalence of phantom vibrations encountered in our sample attests to the fact that normal brain mechanisms are at work. Why some individuals experience it while others do not, why it is more common in younger people (or house staff), and why some body locations seem to be more prone than others to developing phantom vibrations remain unanswered questions. It may be that neural plasticity of younger people makes them more susceptible to imagining vibrations. Alternatively, it may be that pages received by medical students and house staff are more likely to require urgent attention than those received by attending physicians. Like new mothers who constantly imagine they hear their baby crying, students and residents check and recheck their pagers.

For those who attempted to stop the phantom vibrations, relocating the device was often successful. Also the sensations, which were associated with frequency of use, seemed to disappear if the stimulus was avoided. Refraining from using the device in vibrate mode did not work for everyone, however, and some people felt the device vibrating even when they were not in contact with it.

Comparison with other studies

This is the first report of this phenomenon that we are aware of in the medical literature. In a graduate thesis published in 2007 on "Emotional and behavioral aspects of mobile phone use," David Laramie surveyed 320 adult mobile phone users and found that two thirds had experienced phantom rings,[4] similar to the proportion we report.

Limitations of the study

Our study had several limitations. Firstly, the survey was limited to medical professionals in a single institution. However, our findings are similar to those reported in a graduate thesis studying the general population. Secondly, frequency of use was self reported and may have been overestimated or underestimated. Similarly, efforts to stop the vibrations were also assessed retrospectively without controls. Thirdly, 24% of those invited to participate declined to do so. We tried to hide the exact nature of the survey, but those who took it early may have revealed the content to others and thereby introduced a bias into our sample. Finally, our survey represents a single point in time.

Conclusions and implications

More than half the people on the planet now carry some sort of cellular phone,[5] and many of these will set the device on vibrate mode at least some of the time. If two thirds of these people develop phantom vibrations—even if they are not very bothersome—then the global impact is substantial. If even a small proportion of users experience severe symptoms, then effective treatment will be required. More research is needed to understand why phantom vibration syndrome occurs and how to stop it.

The study was conducted with the goodwill of the participants and investigators.

Funding: None.

Competing interests: None declared.

Ethical approval: Consent was not obtained but the presented data are anonymised and risk of identification is low.

Data sharing: Complete survey and dataset available from MBR at Michael.Rothberg@bhs.org.

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Watch Michael Rothberg and colleagues explain why they did the research and what they found at bmj.com/video

The barrier method as a new tool to assist in career selection: covert observational study

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OBJECTIVE To determine if senior doctors' parking habits and skills are associated with clinical specialty and, if so, whether observation of junior doctors' parking could provide guidance in choice of specialty.

DESIGN Covert observational study.

SETTING Pass-card controlled consultants' car park (parking lot), December 2009.

PARTICIPANTS 103 consultants entering the car park on three consecutive mornings.

MAIN OUTCOME MEASURES The outcomes were specialty and sex of the consultants, manner of approaching the barrier (pass-card ready or not), and time taken to park, exit the vehicle, and walk to a designated area.

RESULTS Approaches to the barrier and parking were recorded for 103 consultants: 28 anaesthetists (22 men, six women), 29 physicians (internists, 18 men, 11 women), 14 radiologists (nine men, five women), and 32 surgeons (30 men, two women). The manner of approaching the barrier (card ready) differed by specialty but not by sex. The total time taken to park (seconds) differed significantly between specialties: surgery (median 68, interquartile range 61-71 seconds), anaesthesia (82, 76-91 seconds), radiology (86, 70-103 seconds), and general medicine (112, 96-136 seconds). The time taken to park was overall longer among women, but this was explained by their specialty (men and women matched by specialty did not differ).

CONCLUSIONS The total time taken to park and manner of approaching the barrier to gain entry to the car park differed across specialties. Surgical consultants were fastest, followed by consultant anaesthetists and consultant radiologists, with physicians slowest. Sex was not an influencing factor. If reproducible in studies of a similar nature the "barrier method" could allow for a low cost means of guiding junior doctors in career selection.

Introduction

In the United Kingdom, interview scores are the main discriminating factor to identify trainee doctors suitable for a specialty, whereas elsewhere references assume more importance.[1] Assessments focus on knowledge rather than personality traits, ability, or aptitude needed for a particular specialty.

Using covert observation of behaviour we investigated the association between senior doctors' parking habits and skills and their clinical specialty. On this basis, observation of junior doctors' parking habits could determine their most appropriate career choice.

Methods

Entries to a consultants' car park (by electronic cards) were monitored on three consecutive mornings (07.15-10.30 am) in December 2009. This open, single level car park, entered by a private road, provides parking for consultants from several specialties. An observer, familiar with the hospital's consultants and their specialty, wore a hooded coat and stood at a partially concealed point. The manner of approaching the barrier was assessed and recorded as "card ready" if the entry card was ready for use. A stopwatch recorded the time (seconds) to approach and negotiate the barrier, park the vehicle, get out of the vehicle, and walk to a designated point. We categorised the consultants by specialty and sex.

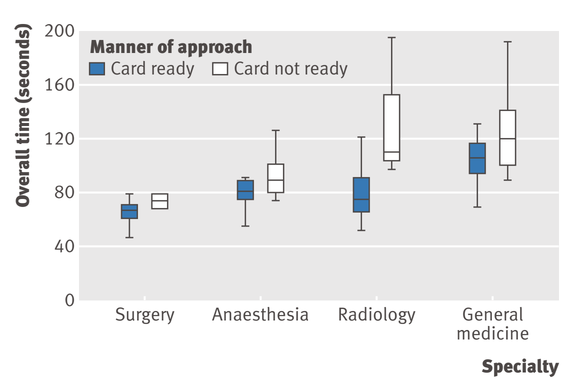
Statistical analysis

We present time (seconds) as medians (interquartile ranges). The difference in manner of approaching the barrier was assessed using the χ^2 test and Fisher's exact test. The Kruskal-Wallis one way analysis of variance was used to analyse the difference in times between all groups. When significant differences were identified we used the Mann-Whitney-Wilcoxon test to carry out further analysis between two groups. We considered $P<0.05$ to be significant.

Results

Approaches to the barrier and parking were recorded for 103 consultants (79 men, 24 women): 28 anaesthetists (22 men, six women), 29 physicians (18 men, 11 women), 14 radiologists (nine men, five women), and 32 surgeons (30 men, two women). One physician was excluded as he arrived to work on a motorcycle and entered the car park through a gap in the barrier system and did not use his electronic pass. One anaesthetist, who thought the observer was a member of hospital management, protested vehemently at his presence and was excluded from the study as time had been prolonged artificially.

Surgeons were significantly fastest (median 68, 61-71 seconds) followed by anaesthetists (82, 76-91) and radiologists (86, 70-103), with physicians the slowest (112, 96-136; table). Surgeons were fastest for all outcomes. The difference in each timed outcome between all specialties was significant (P<0.001; see bmj.com).



Manner of approach to car park barrier and overall time to park, by specialty

OVERALL TIME TO PARK AND MANNER OF APPROACH TO CAR PARK, BY SPECIALTY AND SEX

Specialty and sex	Sample size	Median (interquartile range) overall time (s)	No (%) with card ready at barrier
Surgery:			
Men	30	67 (61-71)	28 (93)
Women	2	85 (77-93)	2 (100)
Total	32	68 (61-71)	30 (94)
Anaesthesia:			
Men	22	82 (75-89)	12 (55)
Women	6	90 (84-91)	3 (50)
Total	28	82 (76-91)	15 (54)
Radiology:			
Men	9	75 (56-80)	7 (78)
Women	5	100 (91-121)	4 (80)
Total	14	86 (70-103)	11 (79)
General medicine:			
Men	18	109 (98-120)	9 (50)
Women	11	122 (97-144)	3 (27)
Total	29	112 (96-136)	12 (41)

Overall time to park was significantly longer among women (100, 91-130 *v* 77, 68-100; P<0.001). Male and female physicians, anaesthetists, and surgeons did not differ. The difference between male (n=9) and female (n=5) radiologists was significant, although the numbers were small (see bmj.com).

The manner of approaching the barrier differed by specialty (P<0.001); 54% of anaesthetists (n=15), 41% of physicians (n=12), 79% of radiologists (n=11), and 94% of surgeons (n=30) had their cards ready (see bmj.com). The specialties differed in total time taken regardless of how the barrier was approached (figure).

Confounding variables were thought to have no influence on the overall results. One anaesthetist crashed into the ticket machine. One physician approached the barrier with his head out of the driver's window to check how close he was to the kerb. Another physician was obliged to open her door to use the pass-card.

Discussion

The covert observation of parking skills (COPS) of consultants showed that surgeons park fastest, followed by anaesthetics and radiologists (no significant difference), with physicians slowest. Men and women matched by specialty did not differ significantly.

Consistency was maintained by using one observer. Few confounding variables existed. The car park is large and availability of parking was not a concern. Information on bags carried was not formally recorded, but most consultants carried at least one into work. No one carried more than two items. It was more common for surgeons than for consultants from the other specialties to carry two items, with several carrying a large bundle of radiographs in addition to a bag. This did not affect the results, as surgeons were the fastest group overall.

Although participants were blinded, the observer was not. Consultants who carried out the study were excluded from analysis. No other consultants in the hospital were aware of the study. The authors are surgeons, and although we accept that this is a potential source of bias, we believe that data were gathered accurately.

When interpreting the data we have assumed that consultants in our unit are appropriate for their specialty, but we cannot be sure. It is unclear if personality traits seen in parking influence choice of specialty or if specialty influences personality. Furthermore, it is unclear if trainees' driving habits are well established early enough to allow for use of COPS as an assessment tool. We would propose that if validated in similar studies, COPS could allow objective assessment of doctors in training and provide them with guidance on specialty choice.

Contributors: See bmj.com.

Data sharing: Statistical dataset and code available from the corresponding author at smccain01@qub.ac.uk.

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Bicycle weight and commuting time: randomised trial

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EDITORIAL by Annas

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OBJECTIVE To determine whether the author's 20.9 lb (9.5 kg) carbon frame bicycle reduced commuting time compared with his 29.75 lb (13.5 kg) steel frame bicycle.

DESIGN Randomised trial.

SETTING Sheffield and Chesterfield, United Kingdom, between mid-January 2010 and mid-July 2010.

PARTICIPANTS One consultant in anaesthesia and intensive care.

MAIN OUTCOME MEASURE Total time to complete the 27 mile (43.5 kilometre) journey from Sheffield to Chesterfield Royal Hospital and back.

RESULTS A total of 30 journeys and 809 miles (1302 km) were travelled on the steel frame bicycle during the study period, compared with 26 journeys and 711 miles (1144 km) on the carbon frame bicycle. The difference in the mean journey time between the steel and carbon bicycles was 00:00:32 (hr:min:sec; 95% CI −00:03:34 to 00:02:30; P=0.72).

CONCLUSIONS A lighter bicycle did not lead to a detectable difference in commuting time. Cyclists may find it more cost effective to reduce their own weight rather than to purchase a lighter bicycle.

Introduction

Last year I acquired a secondhand steel frame bike for £50, spruced it up, and set off using it for my daily commute to work. I soon got into the swing of cycling the 27 miles (43.5 kilometres) from home in Sheffield, to work in Chesterfield and back, managing it most days when I wasn't on call and didn't have commitments off site. After about six months of commuting I began to wonder whether the one way journey time of about 55 minutes could be reduced by a new carbon frame bike.

Evidence based cycling is not high on the bicycle salesman's agenda. No one will tell you how much more efficient one bicycle is over another; they just say it is better. Making a decision on what was perceived to be best and dreaming of extra time in bed, I looked into the UK government's Cycle to Work scheme. This allows an employee to purchase a bicycle (up to a cost of £1000 (€1180; $1560)) at a significant discount by using tax incentives, provided the bicycle is used for commuting to and from work.[1] Doubt has been expressed in the popular press regarding whether the new generation of middle aged men in lycra (MAMILs) are actually using their scheme funded bikes to commute or just to gum up the roads at weekends. I purchased a bike with a carbon frame, lighter wheels, and narrower tyres. All were factors that made me believe that the extra £950 I had spent would get me to work in a trice.

Fig 1 | The author and the two bicycles used in the study, with the steel frame bike on the left and the carbon frame bike on the right

My new bike seemed wonderful, if somewhat uncomfortable. I didn't notice a dramatic decrease in commuting time, nor did the cycle computer I had fitted to it. But, one sunny morning, I got to work in 43 minutes, the fastest I could recall. My steel bike was consigned to a corner of the garage to gather dust—until I had a puncture. The next day I was back on my old steel bike. I fitted the cycle computer, set off . . . and discovered I had got to work in 44 minutes. "Hang on," I thought, "was that minute worth £950 or was it a fluke?" There was only one answer: a randomised trial. I toyed with the idea of blinding it but, in the interest of self preservation and other road users, decided against it.

Methods

This was a single centre, randomised, non-blinded trial; n=1. Both bicycles were of traditional "road" construction with drop handlebars, although the frame of one was made of steel and the second carbon (fig 1; table 1). Identical lights and fittings were used on each bike.

Between mid-January 2010 and mid-July 2010, either the steel frame bicycle or the carbon bicycle was randomly allocated for my daily commute according to the toss of a £1 coin. The time the bicycle was moving for the 27 mile (43.5 km) round trip was recorded with a bicycle computer. Clothing worn was determined by the weather conditions on the morning of travel. The journey, predominantly on urban A roads, included 0.62 miles (1 km) of dual carriageway, 1.86 miles (3 km) of country lanes, and 328 feet (100 metres) of farm track. The total ascent for the round trip was 2766 feet (843 metres). The journey times were entered into a spreadsheet and times compared.

Results

A total of 30 journeys and 809 miles (1302 km) were travelled on the steel frame bicycle during the six month study period, compared with 26 journeys and 711 miles (1144 km) on the carbon frame bicycle (table 2). Two journeys on the steel bike were excluded owing to punctures. One journey on the carbon bike was excluded after an offer of a lift home with a colleague.

The slowest journey was on the carbon bike in heavy snow, and the fastest journey on the steel bike as a direct result of chasing one of my fitter cycling colleagues to work. The average journey time on the steel frame bicycle was 1:47:48 and on the carbon frame bicycle was 1:48:21. The difference in the mean journey time was 00:00:32 (95% CI −00:03:34 to 00:02:30; P=0.72).

Forces acting against the cyclist

Gravity

The difference in weight between the two bicycles is 8.85 lb (4 kg), whereas the rider weighs the same at 167.6 lb (76 kg). The energy expended on lifting the steel bike and rider

TABLE 1 | BICYCLE SPECIFICATION

	Steel frame bicycle	Carbon frame bicycle
Frame	Steel 321 Alloy	Carbon monocoque
Wheels	36 spoke 700C wheel of standard alloy rim construction	20 spoke 700C wheel with alloy rim
Tyres	32 mm Schwalbe Marathon	25 mm Schwalbe Marathon Plus
Pedals	Non-clip	Non-clip
Weight	29.75 lb (13.5 kg)	20.9 lb (9.5 kg)

TABLE 2 | SPEED, DISTANCE, AND JOURNEY TIMES

	Steel frame bicycle	Carbon frame bicycle
Total number of journeys	30	26
Total distance	809 miles (1302 km)	711 miles (1144 km)
Top speed	36 mph (58 kph)	36 mph (58 kph)
Fastest journey time (hr:min:sec)	1:37:40	1:40:50
Slowest journey time (hr:min:sec)	1:57:44	2:03:20
Average journey time (hr:min:sec)	1:47:48	1:48:21

through 2766 feet (843 metres) is about 740 kilojoules, compared with about 706 kilojoules for the carbon bike (see web appendix A). The additional energy expended on lifting the steel bike compared with the carbon bike was 34 kilojoules (5% extra).

Friction (rolling resistance)
The difference in friction (rolling resistance) between bicycles was 0.2 Newtons. The extra power necessary on the steel bike to overcome this difference was 1.2 watts.

Drag
The power required to overcome drag on a touring bike—steel, carbon or chocolate framed—at 15 mph (24 kph) is about 170 watts.

Winter versus summer
The difference between the mean journey time in winter (20 January to 19 April 2010) and summer (21 April to 22 July 2010) was 00:06:50 (95% CI 00:04:39 to 00:08:59; P<0.01).

Discussion
There was no measurable difference in commuting time on the carbon frame bicycle compared with the steel frame bicycle. This is at variance to the intuitive assumption that less weight means more speed. Though a 30% reduction in bicycle weight may seem large, the reduction in total weight (bicycle + rider) of 4% is much less impressive and other forces need to be considered.

Forces acting against the cyclist
Gravity
The additional energy expended on lifting the steel bike was an extra 5%, the overall effect is less as energy is conserved. Gravitational potential energy gained going up will be converted into kinetic energy going down.

Friction (rolling resistance)
Friction (rolling resistance) is relatively small for a bicycle on tarmac and is dependent on the tyre contact area and side wall flex. The manufacturers' literature implied that both sets of tyres had similar resistance.

Drag
Drag is independent of mass and proportional to the cube of the velocity. The power required to overcome drag on the steel touring bike is seven times that required to overcome rolling resistance. The exponential increase in drag with increase in velocity has the perverse effect of counteracting anything else that may increase the speed of the bike.

Acceleration
There is a very good explanation of acceleration on Wikipedia,[2] particularly with respect to wheels, where lighter rims can confer a significant advantage, but only if there are a significant number of points of speed change on the journey. There were not enough on mine.

Winter versus summer
There was a statistically significant difference between times in the first (winter) and second (summer) halves of the trial. Looser shell winter clothing may increase drag by as much as 30%. Fear of falling off might increase journey time in winter; when the road is wet or icy the cyclist is more cautious. Winter is also associated with higher winds.

Traffic
Regardless of whether the bike is carbon or steel, you still have to stop at junctions and red lights.

Implications
Why do so many of us buy "performance" bicycles? Marketing must shoulder some of the responsibility, though we must excuse consumerism, particularly at this time of year, because without it our capitalist society would collapse.

The purchase of the carbon bike made me feel good, and even though the ride is less comfortable, I still commute on it, especially in good weather. I haven't compared the brakes but they seem better. Which do I enjoy riding most? Well, after the trial I have to go for the steel bike. I get there as quickly, and it is more comfortable, better value, and has more "character." If the carbon bike were stolen would I replace it? I'd have to say no. I'd spend the money on high visibility low drag clothing and better lights.

As Lance Armstrong, seven times winner of the Tour de France, said, "It's not about the bike."[3] A new lightweight bicycle may have many attractions, but if the bicycle is used to commute, a reduction in the weight of the cyclist rather than that of the bicycle may deliver greater benefit and at reduced cost.

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1 Department for Transport. Cycle to work scheme—implementation guidance. 28 October 2009. http://www.dft.gov.uk/pgr/sustainable/cycling/cycletoworkguidance/.
2 Wikipedia. Bicycle performance. http://en.wikipedia.org/wiki/Bicycle_performance.
3 Lance Armstrong. *It's not about the bike: my journey back to life*. Yellow Jersey, 2000.

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